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BANDING STUDIES OF WINTERING BALTIMORE ORIOLES IN NORTH CAROLINA, 1963-1966

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INTRODUCTION

The occurrence of the Baltimore Oriole (*Icterus galbula* Linnaeus) in winter in the temperate regions of Canada and the United States, particularly in the Atlantic seaboard states, is a recent phenomenon. The number of Baltimore Orioles reported in winter has increased steadily during the past 17 years and is significantly higher than during a comparable period prior to about 1951. Although a part of this increase may be due to greater interest in and observation of birds in recent years, thus resulting in increased reports of Baltimore Orioles, the increase has been large and consistent enough to be considered as very real. The development of the wintering habit of the Baltimore Oriole in the eastern United States and Canada can be followed through the documentation of the winter sightings of individuals and small groups of birds which have been published in the *Audubon Field Notes* (1949-68). Quay (1968, in manuscript) has compiled these data, together with his own observations for North Carolina, and has presented a review of the development of the wintering habit of the Baltimore Oriole and the present status of this species in the eastern United States. These records have shown, for example, that for the period 1938-48 nine Baltimore Orioles were reported in winter; whereas for the period 1949-60, a total of more than 275 were reported. For North Carolina in comparison, the number of Baltimore Orioles observed in winter during the latter period, but not reported, totaled more than 643. McCaskie, Stallcup, and DeBenedictis (1966) have presented a brief review of records and the present status of the Baltimore Oriole and other icterids and tanagers in California. In this case, the occurrence of Baltimore Orioles in winter in southern California appears to be similar to the occurrence of Bullock's Orioles at times on the east coast. As noted by Quay (*ibid.*), all records of wintering Baltimore Orioles in the eastern United States and Canada have been from urban and suburban areas only and have been always in association with feeding stations. McCaskie, *et al.* (*ibid.*), also mention that in California the Baltimore Oriole is usually found at feeding stations.

The significance of this fact in relation to the occurrence of this species in winter, particularly in the Atlantic seaboard states, is evident.

Known published records of live returns of Baltimore Orioles in winter include those of Lawrence and Brackbill (1957) and of Andrews (1963). Lawrence and Brackbill banded an adult male on 7 January 1953 in Washington, D. C. This bird was color-banded and was identified in two of three successive winters at the same location at which it was banded. Another adult male was banded in Baltimore, Maryland in the winter of 1956, but this oriole was not reported again. Andrews, in Nantucket, Massachusetts, trapped two Baltimore Orioles at her feeding stations, banded them, and kept them indoors through the winter of 1961-62. These birds were released in the spring, and one of them returned the following winter in the full plumage of an adult male.

Van Velzen (1965) gives the total number of Baltimore Orioles banded in the United States, Canada, and Honduras from 1918 through 1962 as 18,478. From data requested from the United States Fish and Wildlife Service¹, the total number of useful recoveries and returns from all bandings of Baltimore Orioles through July 1965 was 550, or about 3 per cent. Of this number, only 15, or 0.08 per cent of the total number banded, were taken in winter in the United States and Canada. These records are indicative of the small numbers of Baltimore Orioles which have been banded and have subsequently returned to the site of banding.

In view of the relatively large numbers of Baltimore Orioles present in winter, particularly in North Carolina (Quay, *ibid.*), it was decided that an extensive program of banding would be beneficial in elucidating more exactly the relative numbers of this species wintering in North Carolina and would contribute to the general knowledge of its status in the eastern United States in winter. During the three winters of 1963-64, 1964-65, and 1965-66, banding and color-marking of Baltimore Orioles were carried out at several selected sites in North Carolina in order to determine relative numbers, rates of return to sites of banding, estimates of population size, sex ratios, extent of local movements, and general behavior.

MATERIALS AND METHODS

The study areas selected for this investigation were all urban and suburban areas of cities and towns in the lower Piedmont and upper Coastal Plain within a radius of about 60 highway miles of Raleigh, Wake County, North Carolina. Banding stations were established and maintained from the fall of 1964 through the spring of 1966 in the following locations:

¹From data requested from the Fish and Wildlife Service, United States Department of the Interior, Patuxent Research Refuge, Laurel, Maryland and contained in Job Number 01-01-001-0571 (3 August 1965).

- Chapel Hill, Orange County: pop. 13,000; located in the lower Piedmont and on the eastern edge of the Triassic Basin about 30 miles west of Raleigh; one mobile banding station operated within Chapel Hill and in Durham, Durham County, about 10 miles to the northeast.
- Fayetteville, Cumberland County: pop. 51,000; located about 60 miles south of Raleigh on the Fall Line between the Piedmont and Coastal Plain (see DePoe, Funderburg, and Quay, 1961, for the physiography of this region); one banding station and three observation stations.
- Fremont, Wayne County: pop. 2,000; located about 50 miles southeast of Raleigh in the upper Coastal Plain; two banding stations, one operated intermittently during the winter of 1965-66; one additional observation station.
- Mount Olive, Wayne County: pop. 5,000; located about 55 miles southeast of Raleigh and about 25 miles south of Fremont, in the upper Coastal Plain; two banding stations, one used only for observation during the winter of 1965-66.
- Raleigh, Wake County: pop. 106,000; located in the lower Piedmont; two banding stations and two observation stations.
- Rocky Mount, Nash County: pop. 32,000; located on the Fall Line of the Coastal Plain about 60 miles east of Raleigh; one banding station and one observation station.
- Zebulon, Wake County: pop. 2,000; located about 20 miles east of Raleigh in the lower Piedmont; one banding station.

A single banding station was operated also in Fayetteville during January and February, 1964 as a pilot station prior to the beginning of the full-scale research. In addition, a single banding station was established in Cary, Wake County, about 8 miles southwest of Raleigh, in February, 1966 in response to the presence of large numbers of Baltimore Orioles reported from that area. The two Raleigh banding stations had been operated intermittently by T. L. Quay from the winter of 1956-57 to the winter of 1962-63 prior to the beginning of this study; data from the banding of Baltimore Orioles during these years, as well as the data from Fayetteville for January and February, 1964, were included in the analysis of bandings and returns for this investigation.

Cooperators were selected in each of the above eight locations to assist in banding, observation, and recording of data throughout the study. These cooperators were mainly housewives and couples with a strong interest in birds and who had large numbers of Baltimore Orioles at their feeding stations. Live-traps were placed near the usual feeding places of the Baltimore Orioles and were tended by the cooperators under my supervision for the duration of the study. The live-trap employed was a simple drop-type trap which doubled as a feeding station, and was selected on the basis of its local availability, its successful operation at the Raleigh stations prior to the beginning of this study, and its selective manual operation. Bait for the trap consisted of the usual food preferred by the orioles, such as pound cake, grapes, oranges or other fruit, peanut butter, and cornmeal-melted fat mixtures.

The method used for marking the Baltimore Orioles for visual identification involved banding each bird with a serially numbered

U. S. Fish and Wildlife Service aluminum band and various combinations of colored plastic bands. The color combinations were developed using six colors of plastic bands and were coded for visual identification in the following manner: for example, B-A—represented a blue plastic band on the left tarsus and a numbered aluminum band on the right tarsus; similarly, B-AR represented a blue plastic band on the left tarsus and a numbered aluminum band over a red plastic band on the right tarsus; and so forth. By using a maximum of three color bands per bird and no more than two bands per leg, a total of 1,068 combinations were available. Each Baltimore Oriole was marked with a different color combination within a given study area; hence, each bird became a recognizable individual within the local population which could be followed in its movements and behavior throughout the winter. However, since the chance for interchange of orioles between study areas was considered to be very small, duplicate sets of combinations were used in each study area. Therefore, only a small fraction of the total possible combinations were used, thereby reducing the complexity of visual interpretation. To further minimize error in records of repeats and returns, observations were made chiefly during periods of strong light, by never using together in the same study area color bands which might be confused, and, whenever possible, by retrapping in cases of doubt.

Sex was determined at time of banding only for adult male Baltimore Orioles. Due to difficulties in sexing by plumage, immatures and females were grouped together at banding. Sex of birds in this latter group was determined only for those birds which subsequently returned and therefore could be considered as having attained adult plumage. No attempt was made to determine sexes surgically by laparotomy.

No attempt was made to perform a complete statistical analysis of the data. The Lincoln index for mobile populations (Davis, 1963; Bailey, 1951) was employed to determine population estimates of Baltimore Orioles for Fayetteville, Fremont, Mount Olive, and Rocky Mount for 1964-65 and 1965-66. These estimates were made from repeat and recapture data obtained by simultaneous observation at several locations within each study area of local movements of Baltimore Orioles on the dates given in Table 3.

RESULTS

Banding, Rate of Return, and Population Estimates

The data from banding and returns are summarized in Table 1 for all study areas, except Raleigh, for 1963-64 through 1965-66. Data for the Raleigh area alone from 1956-57 through 1965-66 are presented in Table 2. Both visual and calculated population estimates for Fayetteville, Fremont, Mount Olive, and Rocky Mount for 1964-65 and 1965-66 are given in Table 3. The 95 per cent confidence limits are obtained by adding to and subtracting from the population estimate two standard errors.

TABLE I. BALTIMORE ORIOLES BANDED AND RETURNED, 1963-66^a

Station Location	Number Banded 1963-64	Number Returned 1964-65	Per cent Returned	Number Banded 1964-65	Number Returned 1965-66	Per cent Returned	Number Banded 1965-66	Total Banded 1963-66
Cary	—	—	—	—	—	—	17	17
Durham	—	—	—	1	1	100.0	1	2
Fayetteville	31	1	3.2	45	18 ^b	40.0	25	101
Fremont	—	—	—	99	34	34.3	85	184
Mount Olive	—	—	—	103	15	14.6	56 ^c	160 ^e
Rocky Mount	—	—	—	58 ^d	10	17.2	0	60 ^d
Zebulon	1	0	0	2	0	0	5	8
Totals	32	1	3.1	308 ^d	80 ^e	25.9	189 ^e	532 (529 ^{c,d})

^adoes not include data for Raleigh (see Table 2).

^bdoes not include the two returns from 1963-64 (see text, Fayetteville).

^c57 banded, one later found dead; included in total banded, but not in calculation of rate of return.

^d60 banded, two later found dead; included in total banded, but not in calculation of rate of return.

^eincludes the two returns from 1963-64 (see text, Fayetteville).

The following are accounts of bandings, rates of return, and population estimates for individual study areas. Accounts of local movements and of sex ratios are presented separately.

Cary. Between 12 February and 12 March, 1966, 17 Baltimore Orioles were banded and color-marked at this station. Since no previous banding had been done at Cary, a rate of return could not be calculated. Observation was not sufficient to permit an analysis of local movements or calculation of a population estimate. However, visual estimation placed the number of Baltimore Orioles present at about 25.

Chapel Hill-Durham. A single Baltimore Oriole was banded in Durham County during the winter of 1964-65. This same oriole was retrapped as an adult female at the same location 27 January 1966. Another Baltimore Oriole was banded at the same location during the winter of 1965-66.

Although the number of Baltimore Orioles banded in the Chapel Hill-Durham area was small, this fact belies visual sightings of up to about 15 different orioles during the study period. The upland forest character of the area may contribute somewhat to a wide dispersal of the few orioles present, as well as to decreasing the total number of orioles in comparison to the sandhill country (Fayetteville area, for example) of the upper Coastal Plain.

Fayetteville. In January and February, 1964, 31 Baltimore Orioles were banded as part of a pilot study for the ensuing two years; 19 of these birds were color-banded. On 27 January 1965, a single return, an adult female, was retrapped about one-quarter mile from its site of banding. No other returns from the 1964 bandings were recorded. The rate of return for this single oriole was 3.2 per cent, a much lower rate than for the returns of the next year. One reason for this low figure was that observation was probably not sufficient during the winter of 1964-65 to pinpoint the occurrence of other returns. Two different Baltimore Orioles banded on the same day as the above return were first observed on 24 January 1966 after an apparent absence of one winter. The rate of return of these two orioles was 6.4 per cent. Together with the above single return, the overall rate of return of Baltimore Orioles banded during the winter of 1963-64 was 3 of 31, or 9.7 per cent.

For the winter seasons of 1964-65 and 1965-66, the Fayetteville banding station was moved to the site of the first return. During the winter of 1964-65, 40 Baltimore Orioles were banded and color-marked at the new location and five were banded at the old banding site. In 1965-66, 25 Baltimore Orioles were banded and color-marked. In addition to the latter bandings there were 18 returns or 40 per cent from 1964-65, plus the two returns from 1963-64 noted above. Including the three returns from 1963-64, the overall rate of return from the winters of 1963-64 and 1964-65 was 21 of 76 Baltimore Orioles, or 27.6 per cent.

TABLE 2. BALTIMORE ORIOLES BANDED AND RETURNED, RALEIGH, N. C., 1956-57 THROUGH 1965-66

Year	Number Banded	Number Returned	Per cent Returned
1956-57	7	2	28.6
1957-58	9	1	11.1
1958-59	1	0	0
1959-60	0	0	0
1960-61	4	0	0
1961-62	0	1 ^a	25.0
1962-63	7	2 (3 ^{b, c})	28.6 (18.8 ^f)
1963-64	21	5 (8 ^{c, d})	23.8 (28.6 ^f)
1964-65	5	1 (3 ^e)	20.0 (11.5 ^f)
1965-66	11	—	—
Totals	65	18 (of 54)	33.3

^afrom 1960-61.

^bone from 1957-58.

^cone from 1962-63 returned two consecutive winters.

^dthree from 1962-63.

^etwo from 1963-64.

^fthese percentages were obtained by adding total returns of contributing years and dividing by total banded in these years.

TABLE 3. POPULATION ESTIMATES OF BALTIMORE ORIOLES AT FOUR LOCATIONS FOR 1964-65 AND 1965-66

Station	1964-65		1965-66	
	Calculated	Visual	Calculated	Visual
Fayetteville	03-13-65		01-25-66	
	44 ± 5.14 ^a	60	53 ± 21.0	80
Fremont	04-10-65		01-27-66	
	114 ± 13.1	125	85 ± 9.80	100
Mount Olive	03-27-65		01-29-66	
	137 ± 28.0	125	60 ± 8.80	100
Rocky Mount	04-03-65		01-21-66	
	101 ± 25.8	90	38 ± 7.42	50

^apopulation estimate ± two standard errors gives the 95 per cent confidence limits on the estimate.

The population estimates calculated for Fayetteville were 44 ± 5.14 for 1964-65 and 52 ± 21.0 for 1965-66. These contrast with visual estimates of about 60 and 80 Baltimore Orioles, respectively. These higher visual estimates were based on a large number of unbanded Baltimore Orioles observed in several widely separated areas at various times throughout the period of the study. The fact that the Baltimore Orioles seemed to be distributed over a wide area of Fayetteville and insufficient observation thereof may account for the low rate of return figures for 1963-64.

Fremont. A total of 99 Baltimore Orioles was banded and color-marked at the two Fremont stations during the winter of 1964-65. In 1965-66, 85 more Baltimore Orioles were banded and color-marked at these two stations. The total number of returns observed from 1964-65 was 34 Baltimore Orioles, or 34.3 per cent.

The population estimates calculated for Fremont were 114 ± 13.1 for 1964-65 and 85 ± 9.8 for 1965-66. These figures are in close agreement with visual estimates of 125 and 100, respectively. This may be attributed to the fact that the Baltimore Orioles were restricted chiefly to the areas of banding and observation and were not widely scattered within the Fremont area.

Mount Olive. A total of 103 Baltimore Orioles was banded at the two Mount Olive stations during the winter of 1964-65. However, only 44 of these birds were color-banded. In the winter of 1965-66, 57 Baltimore Orioles were recorded as returns from 1964-65. This was a rate of return of 14.6 per cent, somewhat lower than the average for all stations, and may be accounted for in part by incomplete coverage of the exact distribution of Baltimore Orioles in Mount Olive.

The population estimates calculated for Mount Olive were 137 ± 28.0 for 1964-65 and 60 ± 8.8 for 1965-66. The visual estimate for 1964-65 was about 125, in close agreement with the calculated estimate. The visual estimate for 1965-66 was about 100 Baltimore Orioles, in sharp contrast with the calculated estimate.

Raleigh. Seven Baltimore Orioles were banded in the winter of 1956-57; two of these, 28.6 per cent, returned the following winter. Nine Baltimore Orioles were banded in the winter of 1957-58; only one of these, 11.1 per cent, returned the following winter. However, one of these orioles, banded as an immature on 29 January 1958, returned as an adult male on 18 January 1964 after an apparent absence (at least from our records) of five consecutive winters. This individual (53-150315) may have been present, but not observed, during the winters between its banding and its return six years later. This oriole provides a minimum longevity record of at least seven years for a Baltimore Oriole in the wild. The rate of return for this bird was 11.1 per cent. Combined with the single return in 1958-59 noted above, the overall rate of return from the nine Baltimore Orioles banded during the winter of 1957-58 was 22.2 per cent.

A single Baltimore Oriole was banded during the winter of 1958-

59, but did not return. No banding was conducted in Raleigh during the winters of 1959-60 and 1961-62. Four Baltimore Orioles were banded in the winter of 1960-61; none of these returned the following winter. However, one of these orioles, an adult female, was recorded two years later in 1962-63, for a rate of return of the four orioles banded in 1960-61 of 25 per cent.

Seven Baltimore Orioles were banded in the winter of 1962-63. Two of these, 28.6 per cent, returned the next winter. Twenty-one Baltimore Orioles were banded in the winter of 1963-64, 5 in 1964-65, and 11 in 1965-66. The returns of 1964-65 consisted of three orioles banded in 1962-63 and five banded in 1963-64. The rates of return were 42.9 per cent and 23.8 per cent, respectively. The combined rate of return for the two years was 8 of 28 Baltimore Orioles, or 28.6 per cent. Of the three returns from 1962-63, one oriole, an adult male, had returned the previous winter also, making a total of four of the seven orioles banded this year returning to the site of banding, or a rate of return of 57.1 per cent. Three Baltimore Orioles returned in 1965-66, and eleven new bandings were made. One of the three returns was from the previous year, a rate of return of 20 per cent, and the other two were from two years before, a rate of return of 9.5 per cent. The combined rate of return for the two years was 11.5 per cent.

In summary for Raleigh, the total number of Baltimore Orioles banded from 1956-57 through 1965-66 was 65. The total number of returns, including those birds which returned more than one time, was 18 of 54 orioles, or 33.3 per cent.

Rocky Mount. Sixty Baltimore Orioles were banded and color-marked at one banding station in Rocky Mount during the winter of 1964-65. No banding was accomplished in 1965-66. Ten of the Baltimore Orioles banded in 1964-65 returned the following winter, for a rate of return of 17.2 per cent. This figure is based on a total of 58 Baltimore Orioles, since two were found dead during the year of banding.

The population estimates calculated for Rocky Mount were 101 ± 25.8 and 38 ± 7.4 , respectively, for 1964-65 and 1965-66. The visual estimates for these two years agreed quite closely, about 90 and 50 Baltimore Orioles, respectively.

Zebulon. One Baltimore Oriole was banded in the winter of 1963-64, two in 1964-65, and five in 1965-66. No returns of any of these eight orioles were reported. This was the only station at which the rate of return was zero.

In summary for all of the banding stations, a total of 366 Baltimore Orioles was banded during the winters of 1963-64 and 1964-65. The total number of returns from these two winters was 90, or 24.6 per cent. Including Raleigh prior to 1963-64, the total number banded was 394, and the total number of returns was 99, or 25.1 per cent. The number of Baltimore Orioles banded during the winter of 1965-66 at all stations was 201, bringing the grand total since 1956-57 to 595.

The population estimates made for Fayetteville, Fremont, Mount Olive, and Rocky Mount are based on recapture methods and may or may not be correct estimates. They may be very much in error since they are based on several assumptions for mobile populations which rarely hold true except for very short periods of time. However, it should be understood that this method was employed merely as a tool to gain an estimate of the range in which the true population might lie. All of the estimates given are minimum figures. Those for Fayetteville for 1964-65 and 1965-66 and for Mount Olive and Rocky Mount for 1965-66 were somewhat lower than the visual estimates from direct observation. Those for Mount Olive and Rocky Mount for 1964-65 and for Fremont for 1965-66 were much closer to the visual estimates.

The large differences in the estimates for the two years of the study, for all stations, may have been due to the differences in weather conditions at the times of the estimates. Those made in 1964-65 were slightly higher due to greater circulation of individuals as a result of the warmer weather of this year. Those made in 1965-66 were slightly lower due to more concentrated feeding by individuals for longer periods of time as a result of the intense cold and snow at the time of the estimate.

Since only limited areas were studied within each city, the actual numbers of Baltimore Orioles present could not be accurately judged and were probably much higher than the figures given. If all cities in North Carolina in which the Baltimore Oriole has been reported are taken into consideration, the total population size in winter may approach several thousands. Ignorance of the status of the Baltimore Oriole in neighboring states at the present time makes it seem probable that North Carolina may represent an area of peak abundance of this species in winter. Recent census reports, however, have indicated that increasingly large numbers are being reported both to the north and to the south of North Carolina.

Sex Ratios

Table 4 presents the sex composition of banded and returned Baltimore Orioles of two classes for different years.

Twenty-eight Baltimore Orioles were banded in the period from 1956-57 through 1962-63. Four of these (14.3 per cent) were classed as adult males at time of banding; the balance were classed as immatures and/or females ($\sigma^7/\text{♀}$). Two of these four males subsequently returned. In addition, two orioles classed as $\sigma^7/\text{♀}$ returned as adult males, and five returned as adult females. Hence, the ratio of male-to-female returns was approximately one-to-one. Assuming that there were no differences in the ability to return, then the sex composition of the previous year's banding could be assumed to be about half male and half female, based on the above ratio.

Fifty-three Baltimore Orioles were banded in the winter of 1963-64. Eight of these (15.1 per cent) were classed as adult males.

TABLE 4. COMPOSITION BY SEX OF BALTIMORE ORIOLES BANNED AND RETURNED DIFFERENT YEARS FOR ALL STATIONS

Year, Class ^a	Banded		Returned ^b	
	Number	Per cent	Number	Per cent
1956-63				
♂	4	14.3	2	50.0 (44.4) ^c
♂/♀	24	85.7	7 (2♂,5♀)	20.8 (55.6)
1963-64				
♂	8	15.1	2	25.0 (33.3)
♂/♀	45	84.9	7 (1♂,6♀)	13.3 (66.7)
1964-65				
♂	50	15.8	14	28.0 (51.7)
♂/♀	265	84.2	46 (17♂,29♀)	10.9 (48.3)
Subtotal 1956-65				
♂	62	15.6	18	29.0 (48.7)
♂/♀	334	84.4	60 (20♂,40♀)	11.9 (51.3)
1965-66				
♂	7	3.5	—	—
♂/♀	194	96.5	—	—

^a♂/♀ is used to represent the single class of immatures or females classed together at time of banding.

^bthese return figures do not include Baltimore Orioles which returned more than one winter, nor those not individually identified by color combination or by band number.

^cfigures in parentheses are percentages by sex of the total returned each year given, instead of by initial banding class.

and two of them subsequently returned. A single oriole classed as ♂/♀ returned as an adult male, and six returned as adult females. This is a decrease in the number of males returning in relation to the number of females returning, but the sample of returns is small and is therefore subject to considerable variation on this basis alone.

In the winter of 1964-65, 315 Baltimore Orioles were banded. Fifty of these (15.9 per cent) were classed as adult males, and 14 of them returned the following winter. Seventeen orioles classed as ♂/♀ returned as adult males, and 29 returned as adult females, a ratio of about one-to-two. The total number of males returning was 31 as compared to 29 females, again a one-to-one ratio. This ratio may again be used to estimate the sex composition of the previous year's banding, showing no essential difference in the ability of males and females to return to the site of banding.

The ratio of males to females in the Baltimore Orioles banded during the winter of 1965-66 was in sharp contrast to the previous years. Only seven (3.5 per cent) of 201 Baltimore Orioles were classed as adult males, whereas the average in all previous years was 15.7 per cent (62 of 395). Although a few more unbanded adult males were observed, the total number was very low. The significance of this fact is not known, but may reflect a good breeding season for the Baltimore Orioles, resulting in the appearance of many more immature birds than in previous years.

Local Movements

The results presented here consist of an analysis of the times of day at which marked Baltimore Orioles were recorded at one or more feeding stations during several observation periods. From this a feeding frequency was obtained for each marked oriole for each station observed. Also, where simultaneous observations were made by several observers, it was possible to determine which individuals fed at several different feeders and thus to determine partially movements between feeding stations for these individuals. However, the intensity of observation was not sufficient at any time to determine completely the full extent of any one oriole's range of movements in a given area. Therefore, these data were used to support conclusions drawn from direct observation concerning the effects of food supply and weather on the patterns of local movements of individual orioles.

The observations for the 1964-65 season were made between mid-March and mid-April, 1965. This period was representative of quite warm, early-spring weather. The observations for the 1965-66 season were in direct contrast to those for the previous winter, both in regard to movements and to weather. These observations were made during the last ten days of January, 1966, which were marked by the heaviest snowfall of the season and by the coldest temperatures. Nine inches of snow accumulated in some areas and temperatures fell to near zero.

Although the observations were made in two different years and are not directly comparable, it was observed that with the onset of cold weather there was a downward shift in the number of Baltimore Orioles feeding and a corresponding upward shift in the frequency of feeding at any given station. This was a very general trend and was consistent with the idea that the local movements of individuals became stabilized and centered during cold weather around a few key feeding stations where sufficient food could be obtained. In contrast to this, in warmer weather a larger number of orioles circulated among more feeders and fed fewer times at each.

In support of fixed patterns of local movements for the wintering populations of Baltimore Orioles, it was observed that during the above periods small numbers of marked orioles appeared as groups at several different feeding stations during the course of a day. At any one time such a group represented only about 10 to 30 per cent of all the Baltimore Orioles present at that station. The

members of each of these groups appeared to circulate in small flocks of three to five birds or more, always appearing at a feeder within a few seconds of one another. This was consistent with the observations of Helms and Drury (1960) that in stable winter populations of Juncos and Tree Sparrows, groups of four to eight individuals usually traveled together for the whole winter. However, not all individuals appeared to be associated with fixed flocks. Those orioles which fed most frequently, more than about 8 or 10 times per day, usually appeared to be lone birds which did not appear consistently with any one group. The frequency of feeding of these birds was about once every 20 to 25 minutes or less, whereas the small flocks fed at intervals of 45 minutes to 2 hours or more.

DISCUSSION

The initial appearance of the Baltimore Oriole in winter in the early 1950's and the continued presence of this species in the eastern United States has generally been treated with only passing interest. Most documentation has expressed curiosity in the occurrence of this tropical-wintering species, but recently it has been noted that the Baltimore Oriole has become sufficiently common and regularly widespread in winter that it no longer deserves to be classified as a rare winter straggler. For example, Scott and Cutler (1961), in referring to the middle Atlantic coast region, state "The Baltimore Oriole was reported from too many places to list; only a few years ago a winter report would have been greeted with extreme skepticism, whereas now they are regular winter visitors in many localities throughout the region." However, little extensive work, aside from that of Andrews (1963), has been carried out to study the basis of the Baltimore Oriole's continuing presence in winter or its population dynamics or behavior. This study has been an attempt to clarify these points in the Baltimore Orioles wintering in the Piedmont and Coastal Plain of North Carolina.

The rate of return of banded wild birds has been measured for many species for many years, particularly for gamebirds and waterfowl. The figures for these rates of return are generally very low when compared with the very large numbers of individuals banded. For example, studies carried out for various game species with the cooperation of hunters have shown that the overall rate of return of these birds is generally greater than about 10 per cent, whereas the rate of return for most passerine species is about 1 to 4 per cent (Spencer, 1964). Since banding came under the control of the Department of the Interior in 1918, some 11 million birds have been banded; useful returns and recoveries of these banded birds number only about 900,000 (Dorst, 1962). This represents only about 8 per cent of the total number banded.

The reported winter recoveries of Baltimore Orioles prior to the beginning of this study, as mentioned earlier, amounted to only about 3 per cent of all the recoveries for this species. It has become clear from the preliminary banding of the Baltimore Oriole in

winter in Raleigh, from 1956-57 through 1962-63, that the numbers of this species have increased. It was also evident from this work that the rate of return of marked Baltimore Orioles in winter has been much higher than would have been expected for a tropical-wintering species exposed to such a situation. The overall rate of return to Raleigh for the above period, and including the present study, was 33.3 per cent. This indicated a relatively high survival rate and an exceptional ability of the Baltimore Orioles to return regularly to the sites at which they were banded in winter. In support of this, the data from all study areas of this investigation, for the period 1963-66, also indicated a high rate of return—24.6 per cent, nearly ten times higher than that for all Baltimore Orioles banded since 1918.

This high rate of return is more appropriately applied to a comparison with the rates of return of other species which normally winter in the temperate United States. Baldwin (1931) showed for several winter-resident species at Thomasville, Georgia, from 1914 to 1917, that the rate of return to the same wintering area was quite high. Blake (1957) has shown high winter return figures for the Purple Finch and for other species at Hillsborough, North Carolina. Dowling (see Berger, 1961, p. 106) obtained a 31.7 per cent rate of return from 103 Tree Sparrows banded in winter in Missouri. Similarly, Van Tyne (1932) demonstrated the same phenomenon for Indigo Buntings wintering in Guatemala. Therefore, high return rates for winter-resident birds seem to be generally widespread. On this basis, it seems plausible to assume that the Baltimore Orioles which are found in winter in the temperate United States form a population that is localized in urban and suburban areas and may be classified as winter resident.

Factors which have been favorable to the survival and continued presence of the Baltimore Oriole in winter include the age distribution of the birds, food supply, and habitat. The Baltimore Orioles which winter in North Carolina and the eastern United States by necessity consist of adult birds and immature birds which are approaching their first year. Hence, those Baltimore Orioles which survive the winter in North Carolina and other areas have a higher chance of continued survival and return. The fact that these orioles are out of their natural winter habitat removes them from their natural winter predators, but it also exposes them to the possibility of new predators in their new habitat and to the rigors of temperate winters. However, there have been no indications of large losses to predation in any area, especially since observation indicates fairly stable winter populations. This species has apparently overcome the problem of facing cold weather and has adapted well to survival in the temperate United States in winter.

The primary factor which has been most influential in the survival and adaptability of the Baltimore Oriole has been the availability of sufficient amounts of proper food at numerous feeding stations. Since it has been observed that the Baltimore Oriole

has been found only in association with urban and suburban feeding stations in winter, it is evident that feeders have been instrumental in the survival of these birds. No Baltimore Oriole has ever been observed in winter at any great distance from such stations for any length of time.

A consideration of the habitat occupied by the Baltimore Oriole in winter has shown that the largest numbers of birds are found in those yards in which the vegetation most closely approximates the forest edge. These yards are park-like in appearance and contain profuse amounts of broad-leaved evergreen shrubs and trees, such as *Azalea*, *Camelia*, *Nandina*, *Ligustrum*, *Magnolia*, *Pittosporum*, and others. This type of habitat may be comparable to the normal winter habitat of this species in Central and South America. More open yards with fewer trees and shrubs of this type attract proportionately fewer orioles.

The recent development of the wintering habit of the Baltimore Oriole has not been purely a chance phenomenon of numerous winter stragglers. Many reports are published each year of single individuals of many species of birds which become stranded in winter in the United States. However, since such large numbers are consistently present, the case of the Baltimore Oriole appears to represent a much different phenomenon. How this wintering habit originated is not known and can only be speculated upon. For example, Andrews (1963) presents three ideas: 1) that the Baltimore Oriole may be undergoing an evolutionary change which would tend to shorten its migratory range; 2) that there may be a weakness in the migratory instinct of certain individuals; and 3) that the appearance of the Baltimore Orioles in winter may simply represent an interruption in the normal migratory pattern due to weather or related factors.

The first two of these ideas are essentially the same and represent the crux of my own ideas concerning how the wintering habit may have begun. However, the third idea does not seem to me to be completely tenable, since there are and, seemingly, will always be large numbers of Baltimore Orioles present in winter not directly related to the weather in any given year.

To expand on these points and to include some further postulations and evidence, I would like to present the idea that the origin of the wintering habit of the Baltimore Oriole could quite conceivably be the result of a combination of the following: 1) some evolutionary change, perhaps a mutation affecting either the behavioral mechanisms involved in migration or the immediate physiological basis for migration; 2) learning and social facilitation following the first appearance of the Baltimore Oriole in winter, such that the numbers gradually increased to present levels; and 3) a change in the general climate over the eastern United States at about the time of the first appearance of the Baltimore Oriole in winter. In support of the latter idea, it has been noted from U. S. Weather Bureau information (Funderburg, 1959) that the winter of 1948-49 marked a peak in a cycle of warm winters which

culminated about 1952. The winters of this period were characterized by temperatures 4 to 10 degrees above normal. This wintering phenomenon may have been induced by or at least facilitated by these warm winters. For instance, a few Baltimore Orioles may have become stranded due either to some mutational change or to the warm winters of the early 1950's, or a combination of both. Then by the process of learning and social facilitation more and more Baltimore Orioles continued to remain longer and longer each year until the wintering habit became firmly fixed in the behavioral pattern of the species.

SUMMARY

1. The Baltimore Oriole (*Icterus galbula*), which normally winters in the tropics, has been found in recent years in winter in the temperate regions of Canada and the United States, particularly in the Atlantic seaboard states.

2. During the three winters of 1963-64, 1964-65, and 1965-66, banding and color-marking of Baltimore Orioles were carried out at several selected sites in North Carolina in order to determine relative numbers, rates of return to sites of banding, estimates of population size, sex ratios, extent of local movements, and general behavior.

3. A total of 366 Baltimore Orioles was banded during the winters of 1963-64 and 1964-65. The total number of returns from these two winters was 90, or 24.6 per cent. Including Raleigh prior to 1963-64, the total number banded was 394, and the total number returned was 99, or 25.1 per cent. These rates of return were higher than would be expected for most avian species.

4. Sex ratios of returned Baltimore Orioles were essentially one-to-one, showing no difference by sex in ability to return to the sites of banding.

5. Population estimates from the local movement data were generally lower than those obtained by direct observation.

6. Flocks circulated in fixed patterns among several feeding stations, with different flocks utilizing the available feeding stations differentially.

7. Factors affecting the survival and continued presence of the Baltimore Oriole were food supply, habitat, and age distribution.

8. Several hypotheses were presented and discussed which could explain the origin and perpetuation of the wintering habit of the Baltimore Oriole in the temperate United States.

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EVIDENCE FROM SALT GLAND ANALYSIS FOR CONVERGENCE OF MIGRATORY ROUTES AND POSSIBLE GEOGRAPHIC VARIATION IN LESSER SCAUP

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INTRODUCTION

Oil pollution resulted in death for thousands of migrating waterfowl in late March and early April, 1963 on the Mississippi River in Minnesota. An account of the effect of this pollution on wildlife has been presented by Peller (1963). A total of 3,333 birds affected by this pollution were picked up. Lesser Scaup (*Aythya affinis*) totaled 65 percent of the sample.

METHODS AND RESULTS

The supraorbital salt glands of Lesser Scaup were dissected and weighed. Supraorbital salt glands, as the name implies, are located above the orbit of the eye and function in the excretion of excess ingested salt. When birds with functional salt glands drink salt water the glands increase in size (Schildmacher, 1932; Schmidt-Nielsen and Kim, 1964). Schmidt-Nielsen and Kim showed that among mallards of approximately the same age, little or no overlap occurs in salt gland weights of birds given fresh water, one percent

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